Victor J. Boucher (2006)
Université de Montréal

Serial-order activation of speech articulators: Neural commands do not operate in terms of segments

Abstract

Introduction: Prominent models of speech-motor control assume that neural commands to articulators follow the sequential order of phoneme segments. As an example, close-open cycles of the lips and jaw in *papapa*… are seen to be serially organized by reference to strings of features like [+cons] [-cons]. Thus, the models prescribe serial commands that activate adductors to close the lips and then abductors to part the lips.

EMG and kinematic data are presented showing that lip and jaw abductors are not active during release openings. Instead, they may represent spring-like behaviour of relaxing muscles. In a spring system, the range and speed of mass displacement are proportional to the contracting force. Applying this analogy, measures of oral pressure and lip compression can be used to approximate contraction force. If release motions reflect muscle elasticity, then pressure and compression would be linearly related to the distance and speed of lip and jaw opening.

Methods and Results: The observations focus on the lip and jaw motions of three subjects who produced several series of *papapa*… and *bababa*… These series were uttered at increasing intensities so as to emphasize changes in compression and pressure. Kinematic and aerodynamic measures were accompanied by a monitoring of onsets of EMG activity for the main jaw and lip abductors and one lip adductor (*orbicularis oris m.*).

Again, onset of EMG activity accompanied closing and compression but not release openings. The main results show that oral pressure, especially, was a strong predictor of the distance and speed of lip and jaw opening ($.896 \geq R2 \geq .402$, $p < .000$ overall).

Discussion: Current models assume that closing and releasing motions in articulators reflect serial activation in terms of postulated targets in a score (as in the *Task Dynamic* model; Saltzman & Munhall, 1989) or strings of equilibrium points specified by the CNS (as in the *Equilibrium-Point Hypothesis*; Perrier & Ostry, 1996). However, the serial ordering of these targets or points is conceived by reference to linguistic notions of segments, as seen in alphabetic-phonetic symbols. The above results indicate that such assumptions may not explain intrinsic factors of releasing movements in articulators. Moreover, close-open cycles in speech articulators are likely to originate from cycles of contraction and relaxation, and not from a priori segmental commands.

References

Perrier, P. & Ostry, D. (1996). The equilibrium point hypothesis and its application to speech motor control. *Journal of Speech and Hearing Research, 39,* 365-378.

Saltzman, E.L. & Munhall, K.G. (1989). A dynamical approach to gestural patterning on speech production. *Haskins Laboratories Status Report on Speech Research*, *SR-99/100*, 38-68

Boucher, V.J. (2006). Serial-order activation of speech articulators: Neural commands do not operate in terms of segments. *Stem-, Spraak en Taalpathologie*, *14*, 45.